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PICTURE OF THE MONTH

Hooked Echo Associated With Snow Showers

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Figures 2 and 3 are time-lapse frames taken of the Sacramento WSR–57 radar repeater scope during the early morning hours of Dec. 20, 1968. A Fairchild recording camera was used. The aperture setting was f/8, and the film was 35-mm Eastman Plus-X, type 4231. Almost all echoes in the photographs are ground clutter. Figure 2 (1136 GMT) shows a weak apparent hook- or 6-shaped precipitation echo (A), which has just moved southward out of the Sierra Nevada foothills to an azimuth of 155° and a range of 35 n.mi. on the radarscope.

Short-lived, false or bogus hooks not associated with mesoscale circulations are often observed on radar. However, figure 3 (1245 GMT) and intervening frames taken between figures 2 and 3, but not presented here, show that this hook and its indicated mesoscale cyclonic circulation persisted for well over an hour. During this time, it moved south-southwestward at about 25 kt, passing over the cities of Stockton and Tracy, Calif. Note that in figure 3 the curl of the hook (A) was not as pronounced as it was initially in figure 2. However, the echo mass associated with it had now developed a V-shaped notch and protuberance near B and a near "dry-hole" or echo-free area at C. It is well known that these features—hooks, protuberances, notches, and holes—have on occasion been associated with tornadoes and severe thunderstorms (Battan, 1959). Echo tops were moderately high, varying from 21,000 ft at 1100 GMT to 14,000 ft at 1300 GMT.

The 500-mb chart for 1200 GMT on Dec. 20, 1968 (fig. 1), indicates that this echo was spawned out of an intense cold Low (core temperature −35° to −40°C) centered just east of the location of the echo.

There were no tornadoes, wind damage, or even any lightning reported in association with this echo. However, darkness and the snow showers accompanying it could have prevented possible lightning or funnel sightings. Surface winds at Stockton Airport were only 12 kt from the north-northwest at 1200 GMT and 7 kt from the north-northeast at 1300 GMT. Snow accumulation associated with the echo amounted to about one-half inch at Stockton and one and one-half inches at Tracy.

The fact that this echo showed several features frequently associated with severe weather and yet only appeared as weak (reflectivity factor, Z, 10^3 mm^6/m^{-3}) on the radarscope may be attributed to the fact that reflectivity of snow is about one-fifth that of rain with the same water equivalence (Hiser and Freseman, 1959).

The evolution and life history of this echo is much more spectacular when viewed as a time-lapse movie, since one can then see two scales of cyclonic motion:

1) The curl (with a radius of curvature of 2 or 3 n.mi. and as a result of apparent mesoscale rotation) developing on the hook just prior to the time of figure 2.

2) The larger scale rotation associated with the cold Low, which causes the entire echo mass to pivot about a point near P in figures 2 and 3.

The authors believe that this apparent hooked echo is also noteworthy in that it is the first time, to their knowledge, that such an echo has been associated with snow.

REFERENCES

Battan, L. J., *Radar Meteorology*, The University of Chicago Press, **1959**, 161 pp., (see pp. 110–115).

Hiser, H. W., and Freseman, W. L., *Radar Meteorology*, The Marine Laboratory, University of Miami, Coral Gables, Fla., **1959**, 267 pp., (see p. 115).

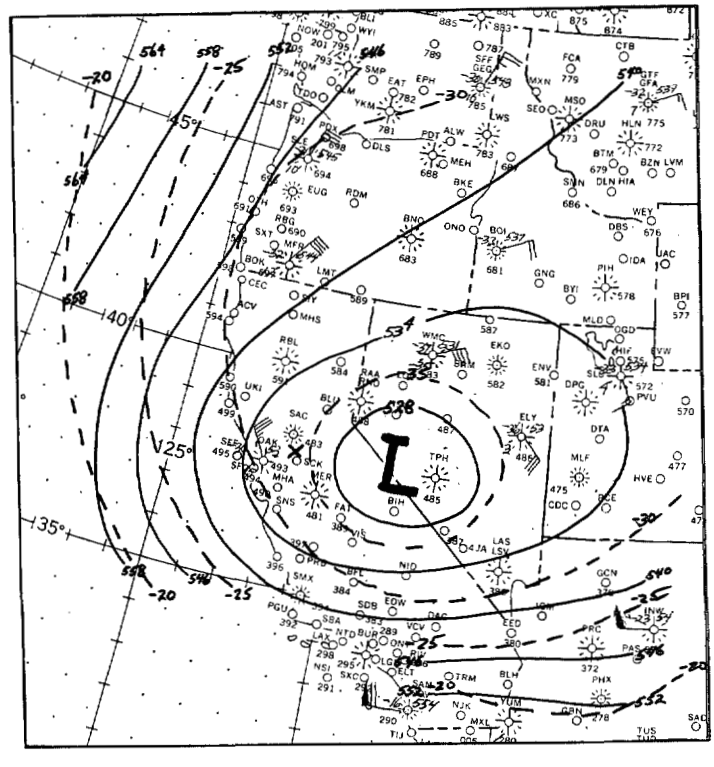

FIGURE 1.—500-mb analysis at 1200 GMT on Dec. 20, 1968 (contours in decameters, isotherms in °C). X marks the location of the hooked echo.

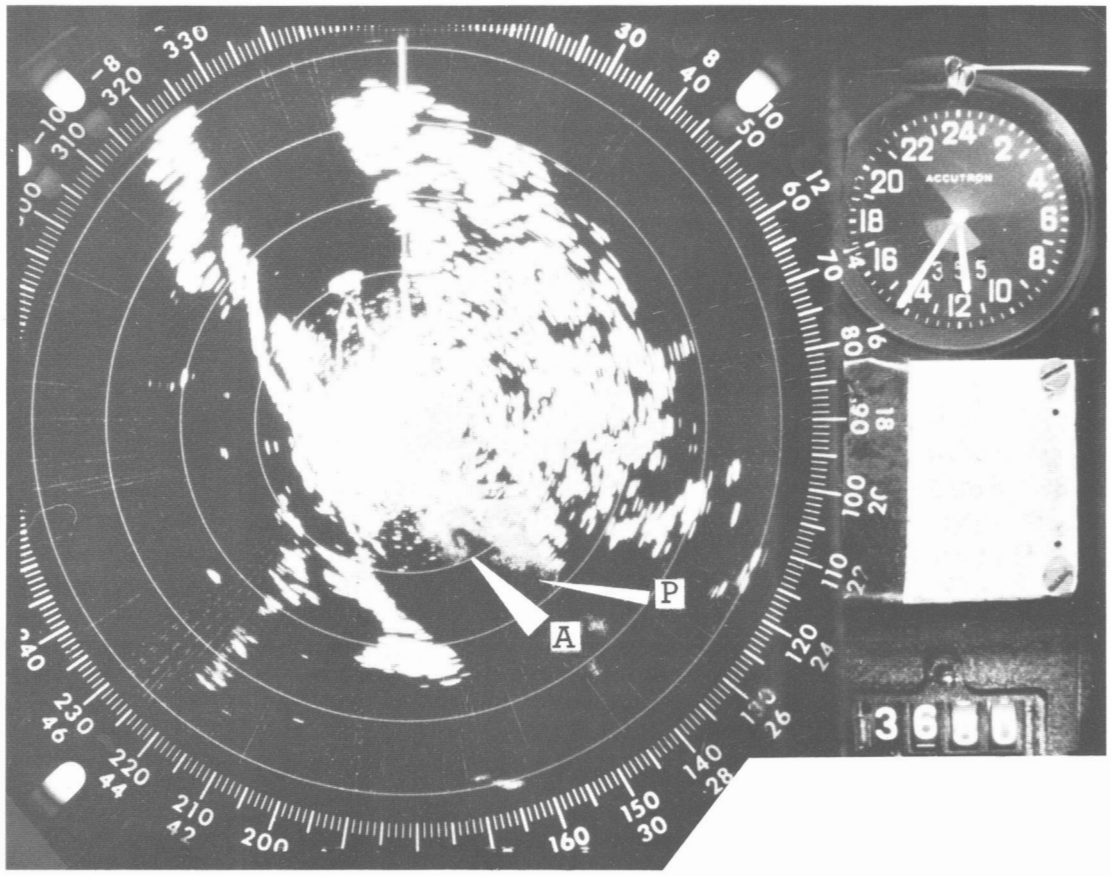

FIGURE 2.—Sacramento, Calif., WSR–57 radar repeater scope at 1136 GMT on Dec. 20, 1968. Range circles are at 20-n.mi. intervals.

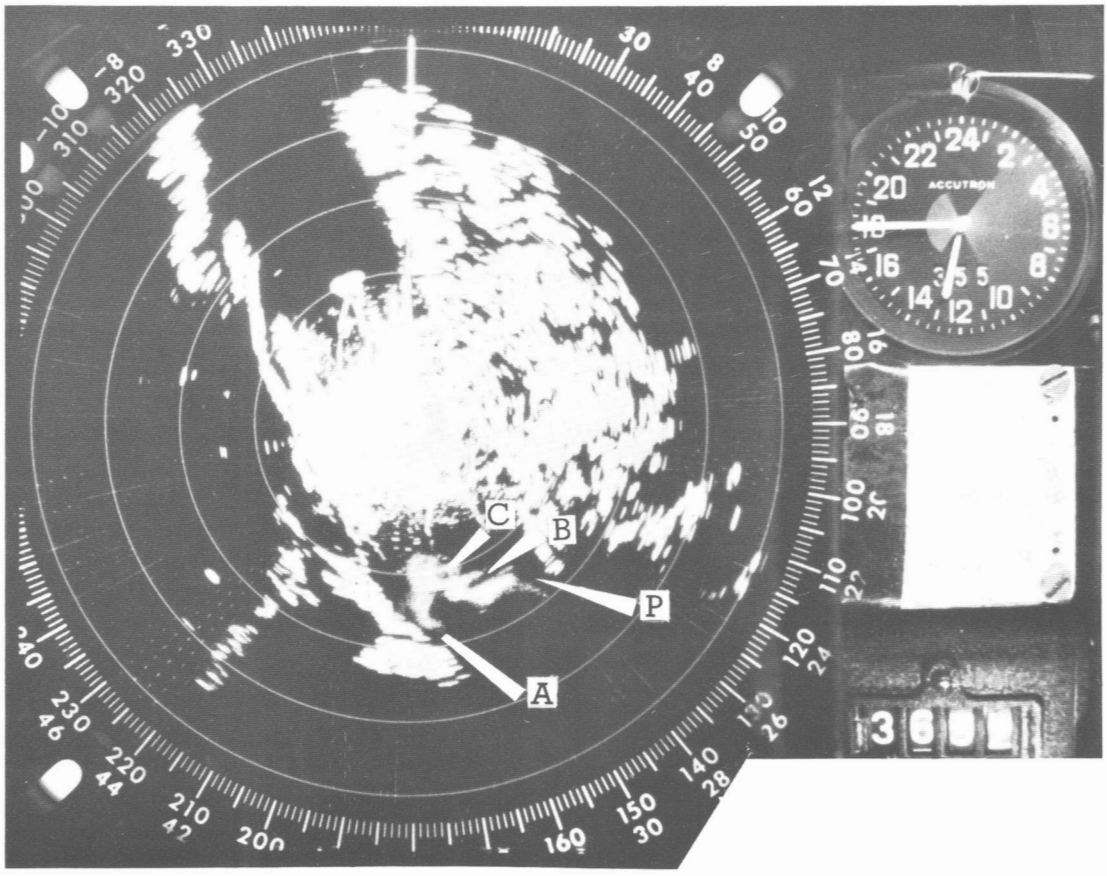

FIGURE 3.—Sacramento, Calif., WSR–57 radar repeater scope at 1245 GMT on Dec. 20, 1968. Range circles are at 20-n.mi. intervals.